Construction and function of the commander Ge 203

THE MECHANICAL CONSTRUCTION

At this point, the structure of the command transmitter should first be considered more closely, because this is essential for understanding the control system: It is at the beginning of the chain of control links.
As will become apparent from the functional description, the transmitter had to be able to independently use the four tone frequencies supplied by the mentioned modulation device (Chapter 2, Fig. 64), depending on the command given by the bombardier -dependent and different for the two rudder levels - to be ' touched ' (Fig. 88). A device was constructed for this purpose, the internal structure of which is shown schematically in Fig. 87. Figures 82 to 86 show real views.

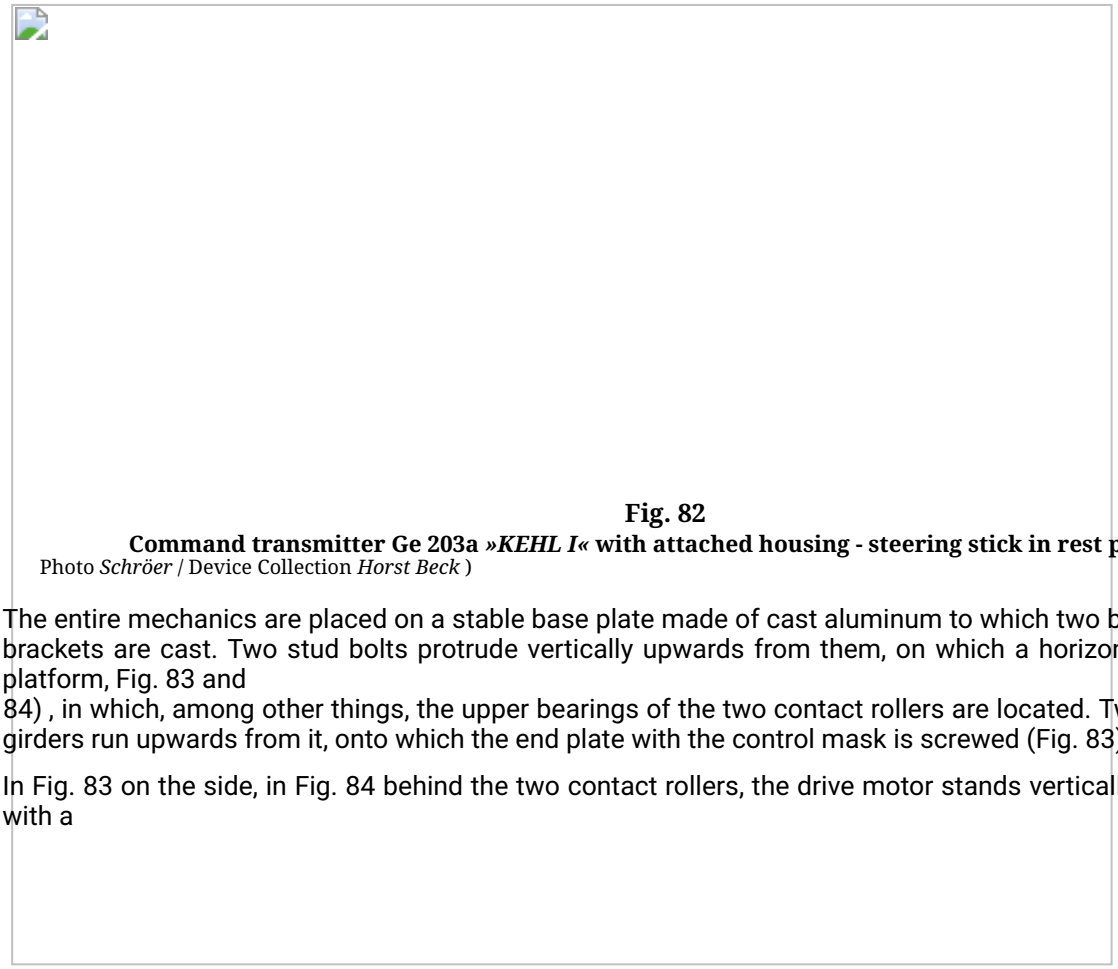

Fig. 82
Command transmitter Ge 203a *»KEHL I«* with attached housing - steering stick in rest position
Photo *Schröer* / Device Collection *Horst Beck*)

The entire mechanics are placed on a stable base plate made of cast aluminum to which two bridge-shaped support brackets are cast. Two stud bolts protrude vertically upwards from them, on which a horizontal platform (storage platform, Fig. 83 and
84) , in which, among other things, the upper bearings of the two contact rollers are located. Two massive, T-shaped girders run upwards from it, onto which the end plate with the control mask is screwed (Fig. 83).

In Fig. 83 on the side, in Fig. 84 behind the two contact rollers, the drive motor stands vertically for the rollers, each with a

Fig. 83

Commander Ge 203a
Upper and lower sliding contact
to contact roller II (left - right)
Brush *slide* (*Sk2*) Brush (*Sk2*)
Control Joint Eye Bolt (Left - Right)
Slide linkage for the brush carriage
Green arrow: Vertical insulating strip
(Photo *Schröer* / Object Collection *Horst Beck*)

connected to a gear. They engage in the significantly smaller drive gear of the motor, so that there is a reduction ratio of 2: 1 (motor speed 600 rpm, roller speed 300 rpm). The roller drive is located in a flat drive housing below the rollers.

The transmission mechanism of the control commands with the help of the joystick is somewhat com plicated, mechanically extraordinarily robust and precisely constructed. Let's follow the structure from the billet head to the roller contacts:

The control stick, which can be detached by turning it over a bayonet, protrudes through the control mask, which limits its lateral deflection more to the left-right than to the top-bottom (Fig. 86a). Its lower end is conical and rests, freely movable in all directions, in a corresponding bearing.

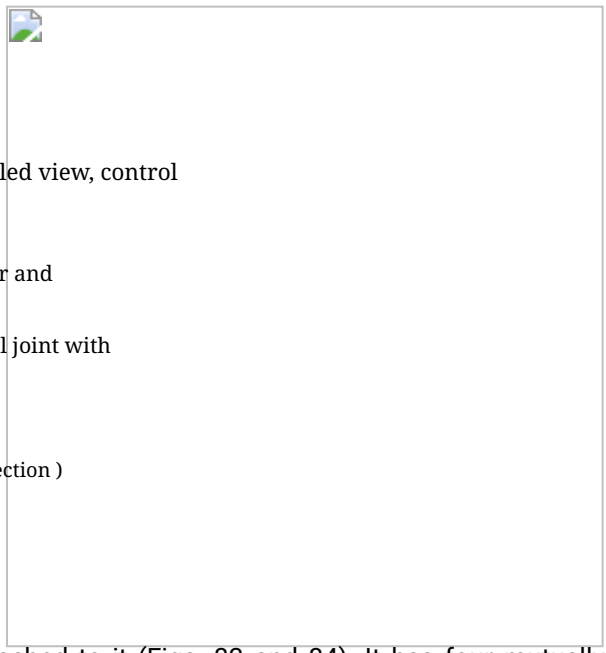

Fig. 84

Command transmitter Ge 203a (detailed view, control stick removed)

Contact roller I: front - back
Contact roller II: left - right upper and lower
Sliding contact
at the ends of roller II universal joint with eye bolt
to the return springs

(Photo *Schröer* /
Object from the *Horst Beck* collection)

The cast aluminum hinge cap is attached to it (Figs. 83 and 84). It has four mutually offset universal joints on its lower edge. In two of them - they are at an angular distance of 45 ° from one another - two strong steel springs (return springs)[1] are pivoted in via eye bolts. They consist of approx. 2 mm thick steel wire, each has 12 turns (eight of which are spaced apart, four are ' shaped '), whereby the distance between the turns decreases towards the ends. At the top, the springs sit in a washer each, which serves on the one hand to fasten the eye bolt of the assigned cardan joint and on the other hand to clamp the spring.

The extraordinarily stiff clamping and construction of the return springs means that as soon as the bombardier releases it after completing a command, it automatically jumps back to its center position, which corresponds to command zero.

1 In *Stüwe* (p 303) states in this regard: *"The vertical position received the billet by means of four tension springs* [..] *, with the same tensile force the shell-shaped bearing element* [..] *held in a horizontal position*

... " In the illustrated here donors are there are only two that act as tension and compression springs at the same time. It is possible that there was also the variant described by *Stüwe* .

For this purpose, the springs are firmly clamped at their lower end, while at the upper end they can be reversibly deformed in all directions via joints, without being able to significantly deflect sideways due to their massive construction . In this way, they act as tension or compression springs depending on the stick deflection.

Fig. 85
Command *transmitter GE 203A*
From the joystick
seen on the return springs
(For details see text)
(Photo *Schröer* / Object Collection *Horst Beck*)

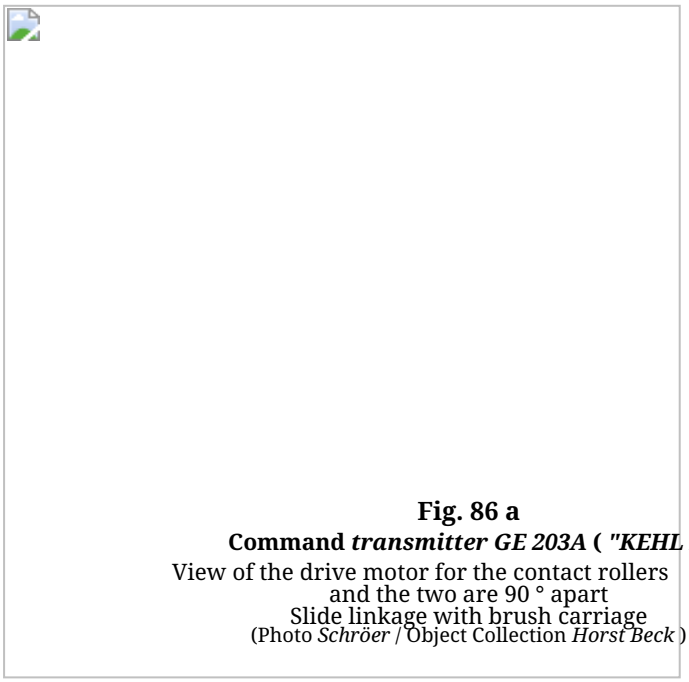

Fig. 86 a
Command *transmitter GE 203A* (*"KEHL I"*)
View of the drive motor for the contact rollers
and the two are 90 ° apart
Slide linkage with brush carriage
(Photo *Schröer* / Object Collection *Horst Beck*)

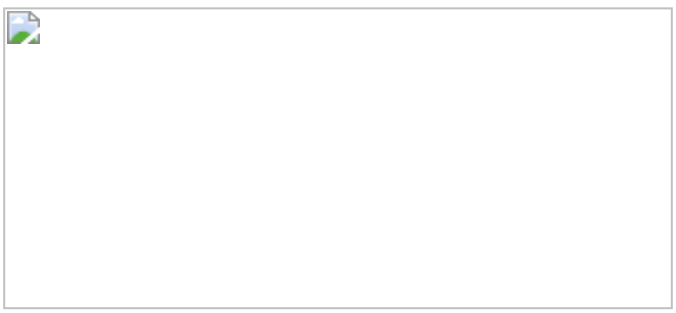

Fig. 86 b
Command *transmitter GE 203A*
Cardan joint to the contact roller I
Joystick
Control mask joint cap
Universal joint lever arm
Slide linkage for the
Brush slide
(Photo *Schröer* / *Horst Beck* Collection)

The other two cardan joints are designed differently in terms of construction. In contrast to the former, they are 90 ° apart on the lower rim of the cap and operate via a lever arm each - it lacks the return joints - here too via eyebolts - the vertical sliding linkage consisting of two columns.

sliding contact slide (brush slide; see fig. 83 and 84) on which the adjustable contact brush is attached. This construction is identical for both command levels (Figure 86a).

If the control stick is now actuated in one direction or the other, the brush slides up or down over the metallized contact roller. In the zero position (no command given) the movable sliding contact is adjusted so that it rests exactly in the middle of the roller. Reference contacts are fixed slip rings attached at the top and on which adjustable contact brushes also run (Fig. 83).

Both the connection lines to the operating voltages of the speed-controlled drive motor and the (time-keyed) audio frequency signals picked up by the rollers are accessible from the outside via a socket strip (*list*) on the base plate .

The entire mechanism sits in a cubic housing, from the top of which only the control stick protrudes. It can be removed after pressing in and turning a bayonet lock. If the large, red-edged stopper (see Fig. 82) is removed, the steering stick can be pushed into the space behind it and does not hinder freedom of movement in the pulpit.

The two smaller screws underneath are used to fasten the cover of the encoder.

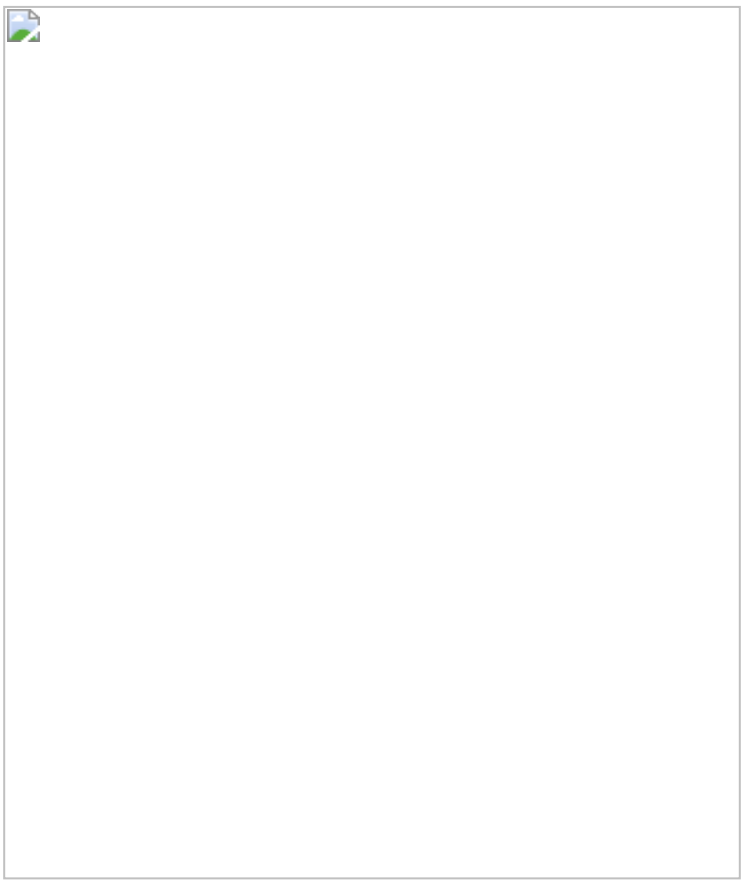

Fig. 87

construction
of a commander
for Cartesian coordinates

The sectional drawing
does not correspond to the structure
the one in the *Beck* Collection
existing encoder!
Presumably it is
to playback
an 'early ' construction.

The drawn
Single elements
do not lie
in the same plane

(after *Stüwe* , edited)

For the function of the command transmitter Ge 203a [2]

Before going into details, here is a brief overview: In the module, four tone generators generate four tone frequencies F1, F2, F3 and F4. Two contact rollers driven by a speed-controlled DC motor (M) rotate at 300 rpm, which corresponds to a 5 Hz movement on the spoiler plates for left-right and front-back control. The symmetrical 'rattling ' with 5 Hz leads to a deflection of the spoilers by the same amount due to the action of the magnets. Because of the inertia of the missile, this corresponds to the command value zero).

Fig. 88

Schematic circuit of the time-controlled remote control Transmitter system with encoder Ge 203a for *»FRITZ X«*

F1... F4 - tone generators **W1, W2 -** contact rollers
Kr1... Kr4 - contact **rings** 1... 4 **Tr -** transformer
Sk1, Sk2 - sliding contacts **M -** drive motor of the rollers

In this sit uat ion, the sliding contacts are Sk1 or. Sk2 in the middle of the contact rollers W1 or. W2, the assigned tone frequencies have the same length. When the sliding contacts Sk1 and Sk2 are moved, the pulse duty factor between the audio frequencies changes (Fig. 88). Correspondingly, the spoiler panels protrude for a long time to one side (up or down or left or right) from the control surface, causing changes in the flow which trigger the desired control effect.

Image 89

Command given by the two-roller system (contact roller I and II) (commutator according to *Marquardt*)

Command coordinates:
Front-back / left-right
K ***0*** **-** command 0 (no command)
KH ***1*** **-** Issue of command 1
(Back and right)

The transmitter function and the generation of control commands and spoiler deflections require an understanding of the entire remote control system. We quote the excellent presentation by *Stüwe* ; The conditions cannot be described better than by him and they also relate to the illustration shown in his book (Fig. 87):

2 There is no clear type designation on the existing nameplates. The suffix a is intended to express that this is the encoder version for Cartesian coordinate control. Some authors also refer to the donor as " *Kehl I "* (cf. *Müller*).

Fig. 90 a / b

Pulse width modulation (time modulation)
for sensing the interrupter (spoiler) of the *»FRITZ X«*

Above: duty cycles for different command values **Below:** Interrupter effect with different duty cycles
(*adapted from Stüwe* and *Kramer*)

"Of the many fundamentally possible methods [of radio remote control] *that were being developed at the time,* [...] *the remote control method with periodic continuous commands and VHF transmission was selected for the operational version and its further developments.*

The term periodic continuous commands meant that even when the command was given zero, i.e. when no command was given by the bombardier, the steering rudders at Fritz X moved around their neutral position in both directions at 5 Hz. As a result, the respective rudder position was too short in relation to its mass to cause a rudder effect when commanding zero to either side. Only when the dwell time of a rudder was increased by a command to one side over a certain period of time did a noticeable rudder effect appear. " [3]

"With him, a high-frequency wave with a certain sampling frequency was modulated alternately for each control level (vertical and transverse axis) with two audio frequencies each. The quantitative control value for each level was determined from the temporal relationship (see length of stay) of the two tone frequencies. [...]

When [the " Fritz X "] *was* [...] *their own Stabili-tion about the longitudinal axis by a gyro to separate interrupter (rowing) was added, so that the remote steering without coupling with*

the self-stabilization on the elevator (front-rear) and rudder (left-right) could take place. The rudder levels were thus fixed during the free fall of the bomb in the room - from the drop to the impact - which was the prerequisite for the guidance by a bombardier.

The two steering coordinates front-back and left-right with Fritz X were to be addressed as Cartesian coordinates [ie each deflection of the encoder corresponds to a unique value pair according to the inclination of the longitudinal axis and side, with command 0 the encoder is in the middle of the Control field and on rollers I and II at K_0, see Fig. 89; d. Author] .

Since the spoilers (spoilers) were simple in their mechanical and aerodynamic mode of operation, the received scanning frequencies could be passed directly from the relay of the receiver to the magnet coils of the rudder, and the evaluation of the rudder deflection could thus be left to the evaluation of the rudder deflection without a special connection of the summing aerodynamic effect. The effort involved in production, assembly and monitoring was therefore low, and a few test devices were sufficient.

After describing the general remote control principle of the Fritz X drop bomb, we want to turn to the high-frequency components of the remote control transmitter system in the carrier aircraft and the radio control receiver system in the missile .

3
The remote control transmission system with the *"Kehl"* transmitter and the *"Strasbourg"* receiver was the only equipment set actually used in the Air Force.

Fig. 91

Schematic representation of the interaction between modulation part, Commander and Radio remote control transmitter *»KEHL«*

Time keying principle

Commands:
V - front **H -** back
L - Left **R -** Right

(Designations see fig. 74 and 79a)

(after *Stüwe* , changed)

A transmitter S 203 was located in the carrier aircraft, which was alternately modulated for each of the two missile axes with a command frequency pair f1, f2 and f3, f4 that generated the tone generators TG1 to TG4 of the modulation part MT 203. The keying of the transmitter was periodically

effected for each level by two command contacts KK1 / KK2 and KK3 / KK4 from the command transmitter Ge 203a ("stick"). The tunable carrier frequency channels [..] *were frequency-stabilized by an exchangeable crystal Q* [Fig. 91] .

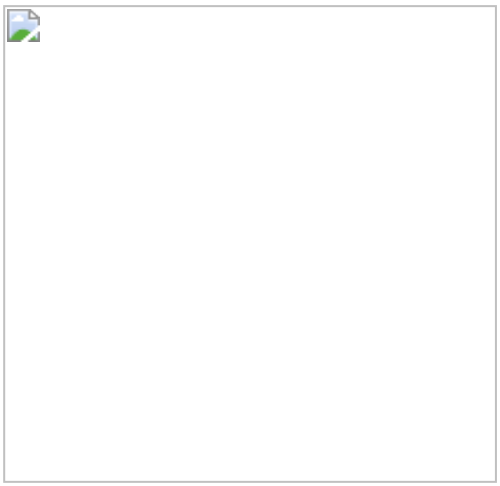

Fig. 92

Vertical insulating gap on the contact roller of encoder Ge 203a

The radio frequency energy modulated by the MT203 from the S203 transmitter was transmitted via the antenna adapter AAG and the special radio steering antenna [..] of *the aircraft* .

On board the remote control body, the given commands were picked up by the receiving antenna EA and passed through the antenna adapter *AAG* [AGE = adapter receiver in Fig. 94] *to the receiver E230. After amplification and demodulation (HF part, IF part, LF amplifier and the filters F of the LF part), the filtered out command frequencies f1 to f4 were rectified and fed to the relays R1 and R2. Fritz X had two polarized relays (T-relays) with their contacts r1 and r2. The gyro rudders mentioned above were operated by the gyro, the function of which is shown in* [Fig. 94] *by contact k* [cf. 94 bottom right] .

[...] *For the Fritz X drop, the commander Ge 203a was in the area of the shooter's right hand. It consisted of an elongated box with a square cross-section, from which a steering rod or "stick" peeped vertically upwards, moveable in all directions* [Fig. 82].

[4]

The stick was kept in its vertical position by four tension springs, which held the shell-shaped bearing element in a horizontal position with the same tensile force. If the bombardier released the stick after a deflection movement, it snapped back into its vertical position due to the tension springs, which also meant command zero .

[4] Apparently there have been different embodiments of the captain Ge 203a. The device in the *Beck* Collection has only two springs that are subjected to tension *and* pressure when the control stick is operated. In this case, two appropriately mounted return springs are completely sufficient to return the stick to the zero position.

In addition to the tension springs, two lever transmissions, offset by 90 °, lead from the stick-side ball-shell bearing element to a carbon sliding contact sk 1 and sk2, which slid axially over a rotating and vertically arranged contact roller when the stick was tilted. When the stick was in a vertical position, the two contacts sk1 and were sk2 in the middle of their contact rollers I and II. [Fig. 88]

Each of the two control planes of the missile was assigned a roller. Each roller was divided lengthways into two electrically conductive halves, insulated from one another, by a helical insulating piece [Fig. 89 and 93] .

Stüwes Presentation is incomplete at this point constantly. To the reels in two of each other insulated halves too part-

Fig. 93 a
model
a contact roller
with separated

Insulating gap
Note:
A helical one
Isolation gap is
enough
Separation of
contact
do not break out!

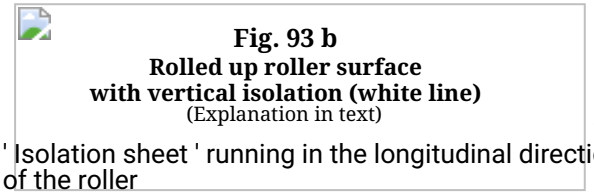

Fig. 93 b
Rolled up roller surface
with vertical isolation (white line)
(Explanation in text)

len, a spiral is enough
shaped separation is not
out. There has to be a
tere, perpendicular in
' Isolation sheet ' running in the longitudinal direction
of the roller be inserted,
which connects the upper and lower spiral track. The picture
the 78a / b should make this clear. The helical separating line
never alone leaves a uniform parallelogram-shaped
ge surface that is only created by the vertical dividing line (white
Line in Fig. 93b) at right angles in two areas Divided triangles
becomes. Such a dividing line can also be seen on photos on closer inspection (green arrow in Fig. 98).

Far he *w ith Stüwe* :

“Their surfaces were coated with a contact silver alloy. If z. B. the modulation frequency f1 was fed to one half of roller I via KK1, slip ring and sk1 and the modulation frequency f2 via KK2 and sk1, the transmitter also gave command pulses of the same length when the stick was in a vertical position because of the equally long contact slides on the roller. at the rear of the missile's receiver . Aerodynamically, because of the shortness and uniformity of the impulses, this meant no steering reaction to the bomb or a command value of zero.

The same thing happened with the same stick position with the modulation frequencies f3 and f4 on roller II, which caused the left-right command pulses. Moved the gunner the stick from the vertical right z. B. forward by a certain angle, the contact sk1 slid up on the roller I, whereby the modulation pulse f1 became longer because of the increasing contact circumference. The contact time of sk1 on roller I for f2 was reduced to the same extent as f1 increased [Fig. 88].

As a result, the two magnetic coils V [SV in Fig. 94] *in the tail of the missile were also excited longer than those of their opposite coils H* [SH in Fig. 94] *. As a result, the period T = T1 + T2 was no longer evenly divided between V and H, but T1 became longer, and the two interrupter flaps SV protruded longer in direction V from the profile of the horizontal tail surface of the tail* [Fig. 90a] *. In terms of aerodynamics, this meant that the flow on the front surface of the tail unit was interrupted longer per unit of time than on the rear side of the wing .*

As already mentioned, a flow interruption on one surface also meant a pressure increase, which in the case of the Fritz X triggered an air force to the rear on the two horizontal tail surfaces, which pushed the rear of the bomb in this direction. As a result, the missile learned a

Tilting b / w. Control moment around its forward center of gravity, so that the bomb tip and with it the entire missile moved forward.

Fig. 94 a / b

Basic circuit diagram of the radio remote control Reception and control system the redirectable drop bomb » *FRITZ X* «
(after *Stüwe* , edited)

From this context, the term »interrupter« for the rudder elements of the Fritz X is understandable, which resulted from their function as flow interrupter. If the steering gate continued to push the stick forward as far as it will go, then the brush contact sk1 as well as the fixed sliding contact KK1 came to rest on the slip ring, whereby a full front command was pressed, since no contact was made with the lower half of the roller and consequently no remaining command H was given. As a result, the interrupter surfaces SV [Fig. 94] *only looked out of the horizontal tail surface in position V. Analogous to the described command V (front), the processes also took place with the given commands H (rear) and, in the second steering level of roller II, with the commands LR (left-right).*

The rollers I and II of the encoder Ge203a for Fritz X (Kehl I) were driven by a speed-controlled DC motor with n = 600 rpm via a spur gear built into the base plate with a transmission ratio of ü = 1: 2. As a result, the contact rollers rotated at 300 rpm, which meant a 5 Hz movement of the breaker surfaces SV-SH and SL-SR [Fig. 94]. *Through the ru-*

As a result, it was possible to correct the trajectory of the missile by ± 800 m in the direction of flight and ± 400 m to the side. "

Fig. 95a / b

Commander Ge 203 (p)
(Potentiometer variant)
Left: command transmitter, housing removed
Right: Detail of the potentiometer

Fig. 96 a / b

Alternative tactile methods for generation the time-frequency signals for a command level
(after *Müller* , edited)

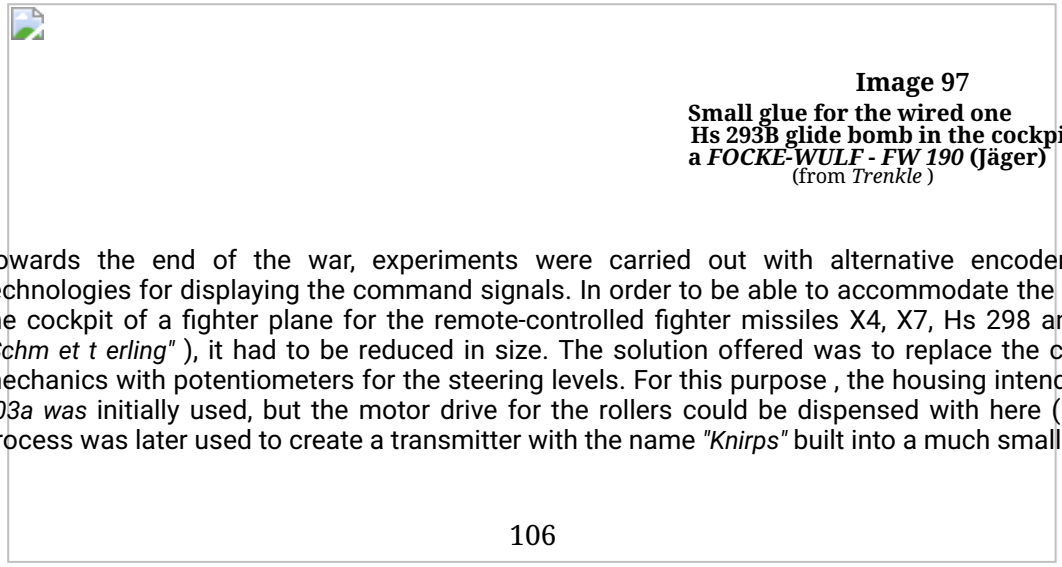

Image 97
Small glue for the wired one Hs 293B glide bomb in the cockpit a *FOCKE-WULF - FW 190* (Jäger)
(from *Trenkle*)

Towards the end of the war, experiments were carried out with alternative encoder and button technologies for displaying the command signals. In order to be able to accommodate the transmitter in the cockpit of a fighter plane for the remote-controlled fighter missiles X4, X7, Hs 298 and Hs 117H (*"Schm et t erling"*), it had to be reduced in size. The solution offered was to replace the complex roller mechanics with potentiometers for the steering levels. For this purpose , the housing intended for the *Ge 203a was* initially used, but the motor drive for the rollers could be dispensed with here (Fig. 95). This process was later used to create a transmitter with the name *"Knirps"* built into a much smaller housing .

Fig. 96b shows basic circuits for the pushbutton electronics with polarized telegraph relays and multivibrators. Fig. 98 shows a functional diagram of the potentiometer transmitter. As far as is known, these have not got beyond the experimental sample.

Fig. 98
Potentiometer command transmitter
for controlling polarized telegraph relays '
(from *Trenkle*)

Advantages of control with the help of interrupter interference edges (spoilers)

In the case of bomb system *"Frit for X"* is - as described above - a St euerung applied in box tail by magnetically actuated interrupter interfering edges (spoiler). With remote-controlled dive bombs, these have a number of advantages over normal oars. This will be reported on in the following , based on statements by *Kram* .

When looking at Figures 58c and 59, it is noticeable that on the top (and bottom) of the spar a structure, known as the leading edge e, protrudes beyond the spar profile (Figure 58e / f). Your job best eht is factory profile to vermin-countries, the boundary layer thickness at Leit and the made of Kant e e sharp profile curvature a Sogspitze, resulting in he-bear witness to a significant increase of the interfering edge efficacy (*stuff it*).

When the *»Frit z X«* was transported, a protective cover made of Plexiglas was screwed over this edge (Fig. 60).

The structure of the interfering edge rudder was described in detail above and illustrated by Figures 53 to 62.

As a reminder: The actual, resiliently 'suspended ' interruption surfaces are extended upwards or downwards from the control system profile when the steering gates give control commands by means of magnetic force, thus acting as a reliever and changing the buoyancy conditions at the Profile of the spars.

The question arises as to what advantages such interfering edges have over 'normal ' elevators and rudders.

For this purpose, the control problems of drop bombs should be pointed out briefly. They are bodies that in principle follow the laws of fall. Depending on the initial speed when it is thrown from the aircraft, its fall curve corresponds to a more or less ' streak ' parabola and its fall is subject to constant acceleration. This allows you to reach the highest speed in the last fall phase, and there is less and less time for effective interventions to change the direction of the body by the guards. It is therefore important to keep the response times of the rudder to given control commands as short as possible. Systems with servo control and indirect connection are too slow for this purpose!

This is exactly one of the advantages of the jamming edge rudder. Your magnet control is almost instantaneous (milliseconds) and the power requirement for control is extremely low, with the *»Frit z X«* per rudder, it is in the order of 4 watts. This power can easily be switched almost in real time by very fast polarized telegraph relays in the receiver output. This means that there is no need to install any switching devices between the remote control receiver output and the rudder.

Another advantage lies in the fact that, in terms of their frequency, the rapid, periodic changes full of breaker deflections, which are matched to the body mass, open up the possibility of achieving any partial effect between zero and full effect. *Kramer* writes:

" If the interrupter follows these alternating impulses with sufficient frequency, so that the inertia of the missile only allows the impulses to have an effect in their mean value, then a simple yes-no control with full deflections has become in the practical end a constant control, without that some extra effort was required. "

The low switching power requirement of the oars also offers the possibility of replacing expensive high-performance accumulators with cheaper dry batteries that can also be stored without problems over a long period of time and that enable the oar system to be supplied with electricity regardless of the position in the body. Of course, this does not apply to the power requirement of the remote control receiver, which still has to be supplied from accumulators with a downstream converter.